On system-level analysis and techno-economics of BET

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SIX HOVE annual seminar 23.9.2025

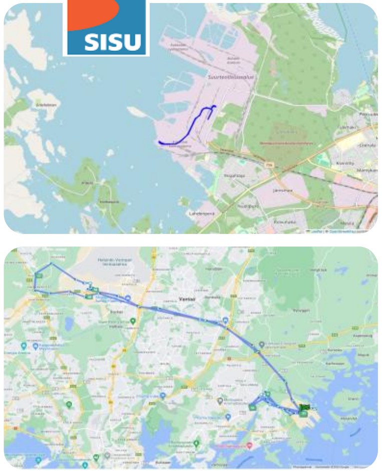
Objectives

- Development and demonstration of high-efficiency long-haul b-HDV(2), f-HDV(3) and r-HDV(4) at a minimum GVW of 40t with +750km unrefueled/uncharged range.
- Development and demonstration of cost-effective standardized modular electric multi-powertrains in real-world conditions for a minimum 500 km daily operation under full load for 6 months.
- Development and demonstration of grid-friendly fast charging solutions
- Seamless integration and fluid operation of Zero-emission HDV fleets both in-route (TEN-T and highway hubs) and in the storage depots/logistics hubs.
- Development of 4 Modular Digital Twins of demonstrator vehicles for assessment, continuous optimization and LCA.
- Being a Global Leadership for European Automotive, Logistics, and Infrastructure & Powering EU Absolute Zero Future.

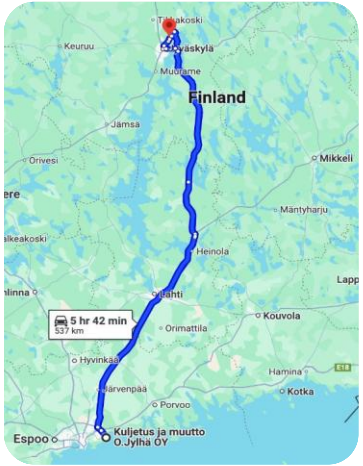
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101096598.

ESCALATE & SIX HOVE pilot

P1: SISU, Finland

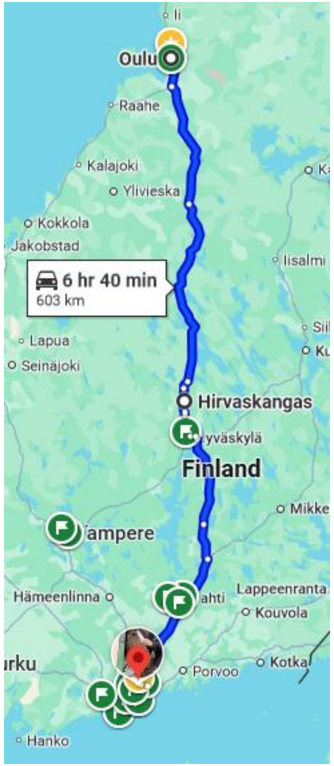


Port of Kokkola



Helsinki - Jyväskylä

P2: SIX HOVE virtual replication Vantaa-Oulu (roundtrip)



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TCO cross-analysis of demonstrator designs vs pilots & missions

The vehicle configurations analysed for **each pilot mission/route**:

A. Conventional diesel truck (baseline case across the analysis)
B. Battery electric truck with a large battery aiming at maximum range with overnight depot charging,
C. Battery electric truck with an intermediate battery combining overnight depot charging and fast opportunity charging,
D. Range-extending plug-in battery electric fuel cell truck, two energy management variants analysed
    1. Depot charge and H_2 refill, without opportunity charge
    2. Depot charge and H_2 refill, with opportunity charge
E. Fuel cell truck with a small non-chargeable battery.

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Three demonstrator designs (+ SIX HOVE variant)

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	Demonstrator 1 (SISU)	Demonstrator 2	Demonstrator 4
Vehicle type	FC range-ext BET	Fuel cell truck	Battery-electric truck
Axle configuration	6x4	4x2	6x4
Battery capacity (kWh)	644 (SIX HOVE: 1000)	30 (SIX HOVE: 80)	1100 (1600)
Fuel cell power (kW)	120 kW	240 kW	-
Hydrogen capacity (kg)	58	80	-
Electric motor nominal power (kW)	350	300	350
Tractor curb weight (kg)	11634	7349	12986
Gliders weight (kg)	7500 / 17500	7500	7500
Max payload	22866 / 41500	25500	21514
GVW	42000 / 70634	40125	42000
Payload capacity vs diesel	97%	100%	92%

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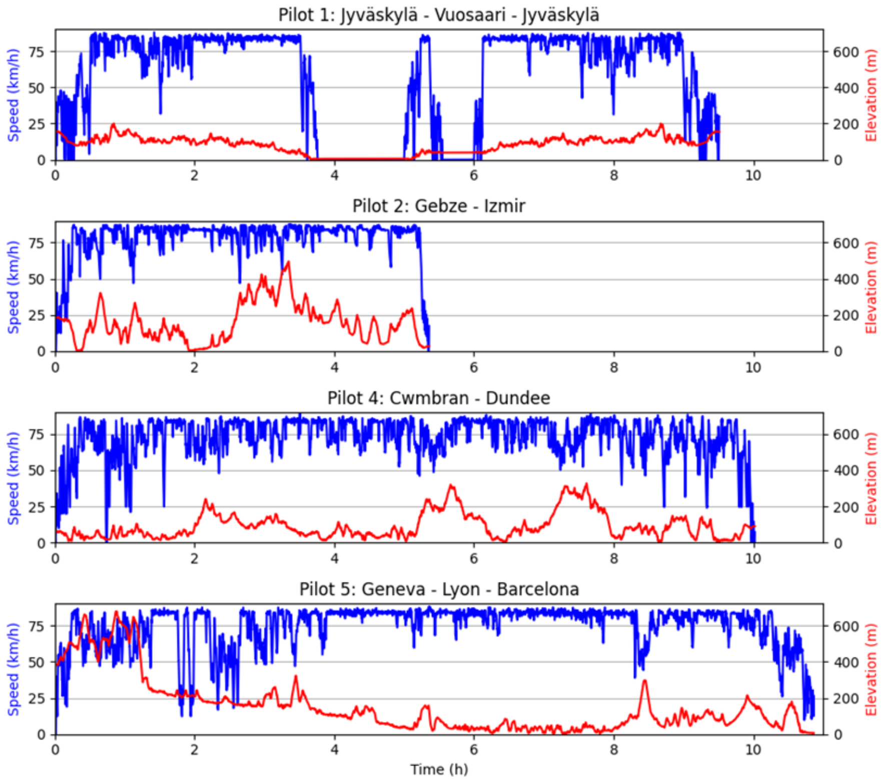
Creation of driving profiles for each pilot route

High-level inputs used for driving profile and operational scenario construction:

- Ambient temperature 25 C assumed
- Modular scalable base vehicle model using known high level parameters by demonstrator
- Vehicle own mass estimated from the high-level specification
- Estimated full payload capacity case analysed
- Operational scenarios and charge/refill strategy taken from the high-level description



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High-level details of the pilots

	Pilot 1 (SISU)	SIX HOVE
Mission analysed (LH)	Jyväskylä (J)– Helsinki (H) (FI) (roundtrip)	Vantaa – Oulu – Vantaa (roundtrip)
Mission length (km)	540	1200
Av. speed on mission (km/h)	72 (a) 69 (b)	77
Mandatory breaks	1	2, plus 3-hour break in Oulu
Primary vehicle configuration	3-axle semitrailer (a) HCT (2 trailers) (b)	HCT (2 trailers)
Key infrastructure	H2 refuel (J); MCS charge (H); Depot charge (CCS) (J)	CCS O & D, MCS charging during mandatory breaks (Hirvaskangas), H2 refilling in Jyväskylä

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High-level TCO inputs / assumptions

Parameter	Pilot 1	SIX HOVE Vantaa-Oulu
Annual mileage (km)	162 000	360 000
Depot charger / oppo charger power needed (kW)	160-275 / 716	238-424 / 1060
Diesel / LBG price (€/l/€/kg, VAT 0%)	1.6 / 1.7	
Electricity price with distribution, private (€/MWh, VAT 0%)	120 **(a)** / 100 **(b)**	
Electricity price with distribution, private (€/MWh, VAT 0%)	300 **(a)** / 200 **(b)**	
H2 retail price (€/kg, VAT 0%)	9.5 **(a)** / 6.3 **(b)**	
Private charger price (€/kW)	350	
Battery price (€/kWh) / Fuel cell price (€/kW) / H2 tank price (€/kgH2)	250 / 800 / 1000	

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TCO methodology – three steps

1. Estimate Equivalent Annual cost EAC(1) for the first year of vehicle ownership

$$EAC(1) = EAC_{C,v} + EAC_{C,b} + EAC_{C,fch} + EAC_{C,c} + EAC_{O,energy} + EAC_{O,S\&M} + EAC_{O,labour}$$

2. Formulate NPV of Total Cost of Ownership over the ownership period

$$TCO = EAC(1) + NPV(rate, EAC(2) \ldots EAC(N))$$

3. Estimate the Levelised Cost of Driving (LCOD) by diviging the TCO with mileage (km) or mileage*payload (tonne-km)

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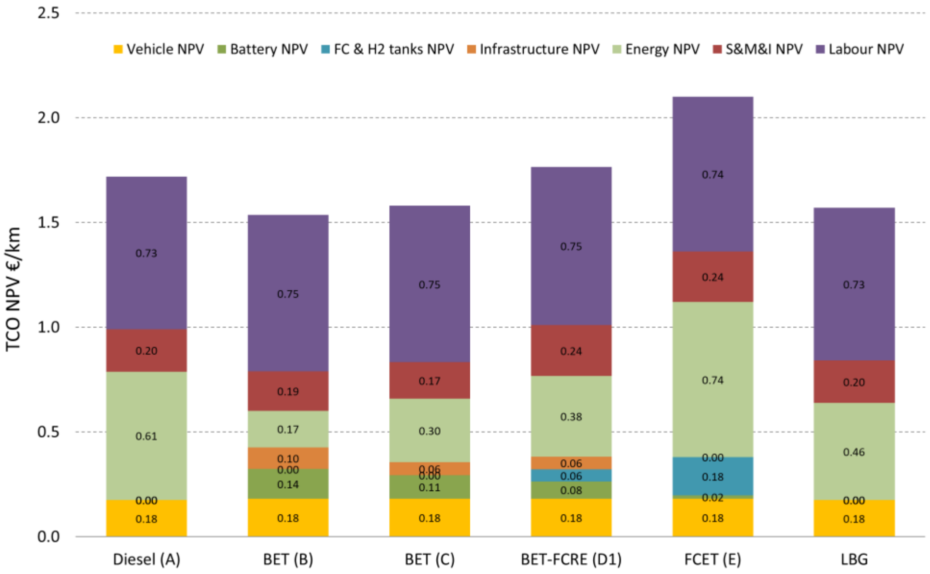
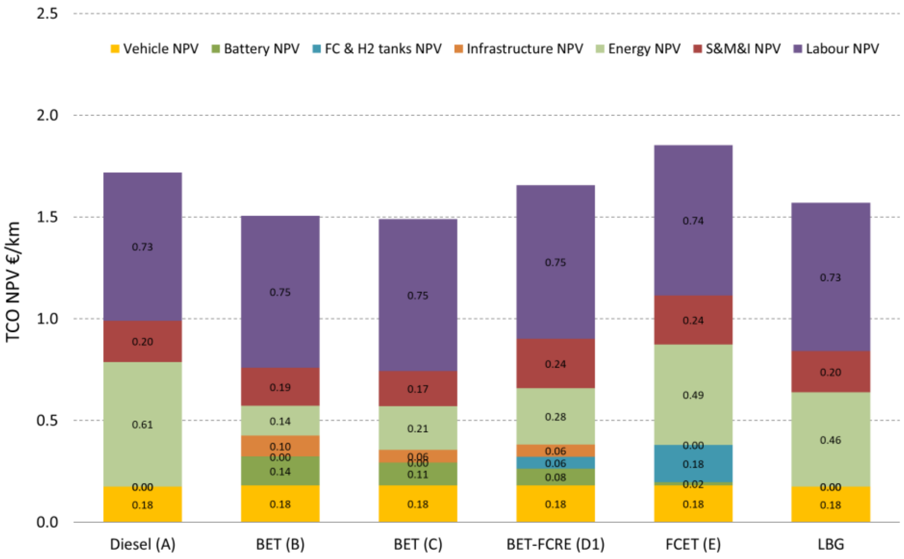
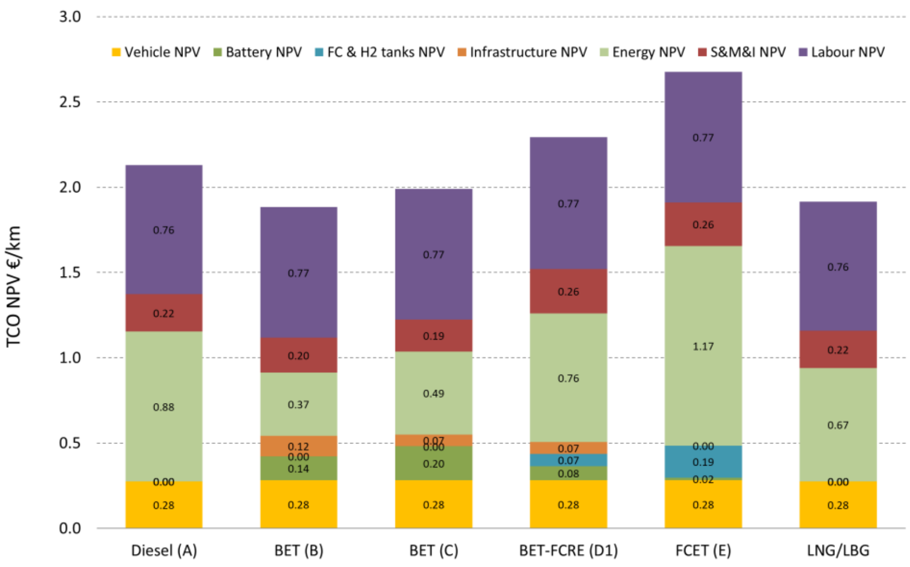
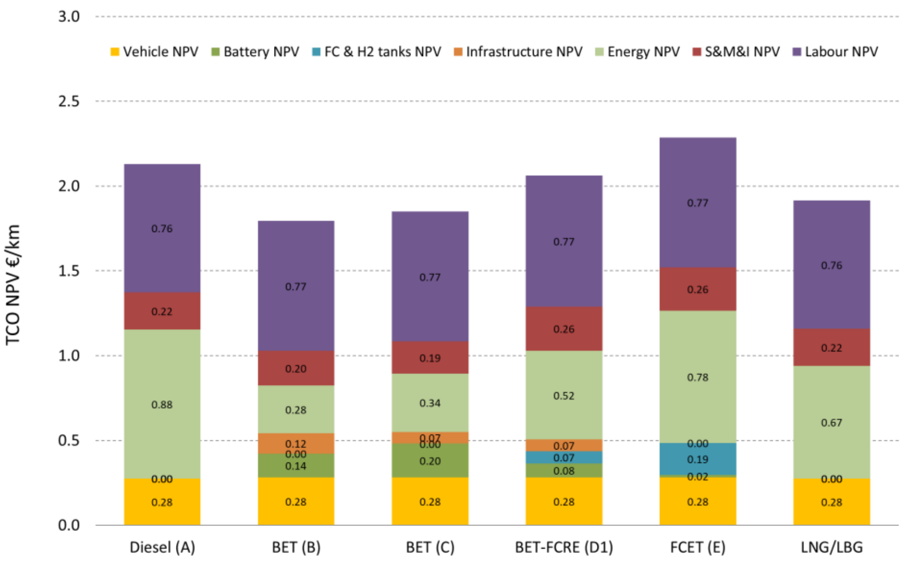
SISU truck at 40t GVW on Jyväskylä-Vuosaari route (a = left, b = right)



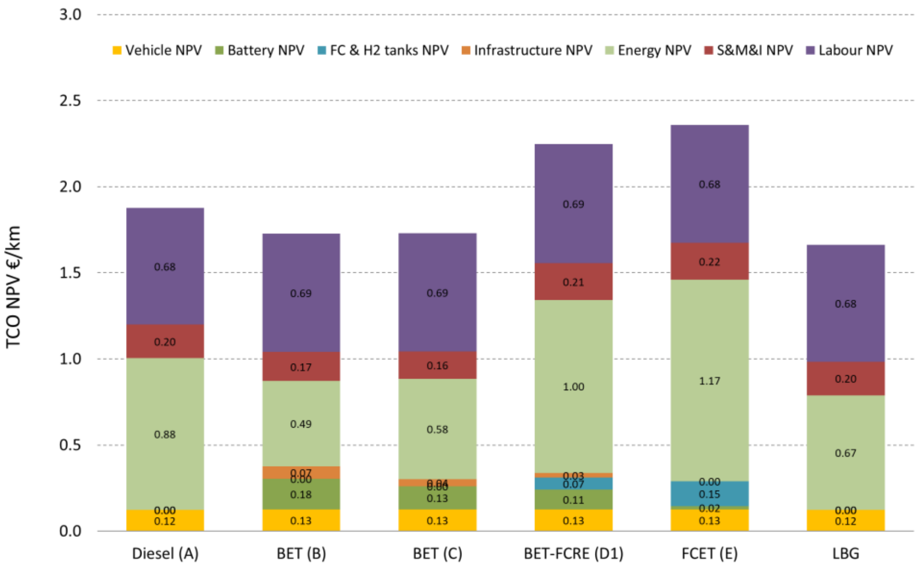


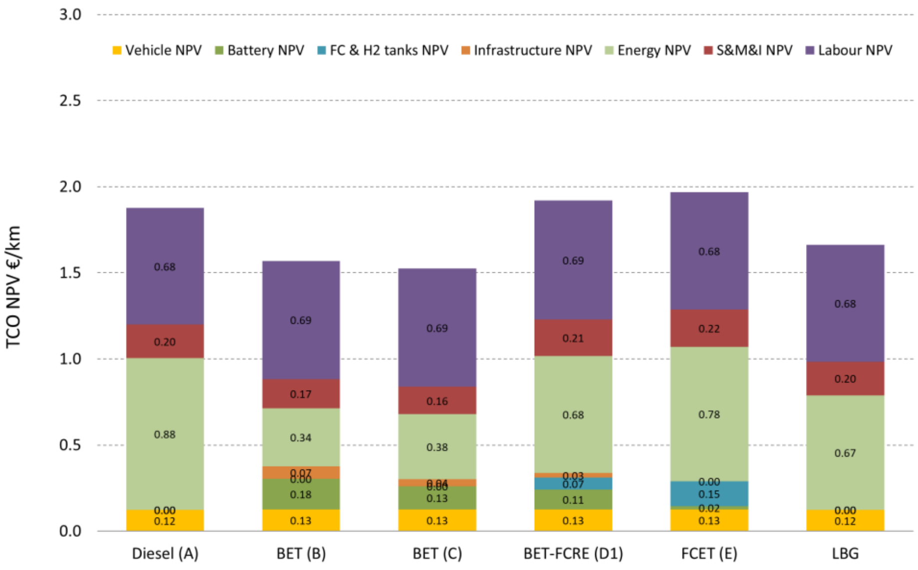
SISU truck at 76t GVW on Jyväskylä-Vuosaari route (a = left, b = right)





Virtual replication Vantaa-Oulu route at 76t GVW (a = left, b = right)





Takeaways

1. MCS will be needed for the long-haul during O/D and mandatory breaks for GWV of 35-40 tonnes and above
2. BET will be competitive compared to both HVO and LBG
3. H_2 and fuel cell trucks business case is very uncertain
4. Access to cheap electicity will significantly improve the BET business case
   - Private charger behind own meter and energy sourcing is beneficial whenever possible
   - If public charging as a service can offer ~0.20 €/kWh (or less), market demand will grow exponentially

beyond the obvious

Thank you!

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